CLAIMS

What is claimed is:

1. A magnetic element comprising:

a pinned layer;

a spacer layer, the spacer layer being nonmagnetic; and

a free layer having a free layer magnetization, the spacer layer residing between the pinned layer and the free layer, the free layer including at least one ferromagnetic material that is diluted with at least one nonmagnetic material and/or ferrimagnetically doped such that the free layer has a low saturation magnetization;

wherein if the free layer includes the at least one ferromagnetic material that is diluted with the at least one nonmagnetic material, then the free layer includes at least CoX, FeX, CoFeX, NiFeX, CoXY, FeXY, CoFeXY, NiFeXY, and/or CoNiFeXY where X or Y is Cr, Cu, Au, B, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, TaCuN, and/or CoFeX where X is Cr, Cu, Au, Nb, Mo, Pt, Pd, ta, Rh, Ru, Ag, TaN, CuN, and TaCuN;

wherein the magnetic element is configured to allow the free layer magnetization to be switched due to spin transfer when a write current is passed through the magnetic element.

2. The magnetic element of claim 1 wherein X and Y are at least five atomic percent and less than or equal to sixty atomic percent, except for Pt and Pd which can be in the range of five through eighty atomic percent.

3. The magnetic element of claim 1 wherein the free layer includes CoX, FeX,

CoFeX, NiFeX, and/or CoNiFeX where X includes at least one rare earth element in a range of five to sixty atomic percent.

4. The magnetic element of claim 3 wherein the at least one rare earth element is Gd or Tb from five to sixty atomic percent.

5. The magnetic element of claim 3 wherein the free layer further includes at least one additional dopant, the at least one additional dopant including Cr, Cu, Au, Nb, Mo, Pt, Pd, Ta, Rh, and/or Ru.

6. The magnetic element of claim 1 further comprising:

a high spin polarization layer residing between the free layer and the spacer layer.

7. The magnetic element of claim 1 wherein the pinned layer includes a plurality of bilayers, each of the plurality of bilayers includes a Fe_xCo_{1-x} and a Cu layer, x less than one.

8. A magnetic element comprising:

a first pinned layer;

a spacer layer, the spacer layer being conductive and nonmagnetic;

a free layer having a free layer magnetization, the spacer layer residing between the first pinned layer and the free layer, the free layer being a low saturation magnetization free layer;

a barrier layer, the barrier layer being an insulator and having a thickness that allows tunneling through the barrier layer;

a second pinned layer, the barrier layer being between the free layer and the second pinned layer;

wherein the magnetic element is configured to allow the free layer magnetization to be switched due to spin transfer when a write current is passed through the magnetic element.

9. The magnetic element of claim 8 wherein the free layer includes at least one ferromagnetic material diluted with at least one nonmagnetic material.

10. The magnetic element of claim 8 wherein the free layer includes CoX, FeX, CoFeX, NiFeX, CoXY, FeXY, CoFeXY, NiFeXY, and/or CoNiFeXY where X or Y is Cr, Cu, Au, B, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, and/or TaCuN.

11. The magnetic element of claim 4 wherein X and Y are at least five atomic percent and less than or equal to sixty atomic percent for Cr, Cu, Au, B, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, and/or TaCuN and at least five atomic percent and less than or equal to eighty atomic percent for Pt and Pd.

12. The magnetic element of claim 8 wherein the free layer includes a multilayer including at least one ferromagnetic layer and at least one nonmagnetic layer.

13. The magnetic element of claim 12 wherein the free layer includes a plurality of bilayers, each of the plurality of bilayers includes a Fe_xCo_{1-x} and a Cu layer, x less than one.

14. The magnetic element of claim 13 wherein x is 0.5

15. The magnetic element of claim 13 wherein the Cu or FeCo layer is greater than or equal to one Angstrom and less than or equal to eight Angstroms in thickness.

16. The magnetic element of claim 8 wherein the free layer includes at least one ferromagnetic material ferrimagnetically doped with at least one dopant.

17. The magnetic element of claim 16 wherein the free layer includes CoX, FeX, CoFeX, NiFeX, and/or CoNiFeX where X includes at least one rare earth element.

18. The magnetic element of claim 17 wherein the at least one rare earth element is Gd or Tb.

19. The magnetic element of claim 18 wherein the free layer further includes at least one additional dopant, the at least one additional dopant including Cr, Cu, Au, Nb, Mo, Pt, Pd, Ta, Rh, and/or Ru.

20. The magnetic element of claim 8 further comprising:

a high spin polarization layer residing between the free layer and the spacer layer.

21. The magnetic element of claim 8 wherein the pinned layer includes a plurality of bilayers, each of the plurality of bilayers includes a Fe_xCo_{1-x} and a Cu layer, x less than one.

22. The magnetic element of claim 8 wherein the free layer is a simple free layer.

23. The magnetic element of claim 8 wherein the first pinned layer is a first synthetic pinned layer including a ferromagnetic layer adjacent to the spacer layer, wherein the ferromagnetic layer has a first magnetization and the second pinned layer has a second magnetization and wherein the first magnetization and the second magnetization are oriented in opposite directions.

24. The magnetic element of claim 23 wherein the second pinned layer is a second synthetic pinned layer.

25. The magnetic element of claim 24 wherein the wherein the second synthetic pinned layer includes a second ferromagnetic layer adjacent to the barrier layer, wherein the second ferromagnetic layer has a second magnetization, and wherein the first magnetization and the second magnetization are oriented in opposite directions.

26. The magnetic element of claim 8 wherein the first pinned layer and the second pinned layer are configured such that charge carriers both from the first pinned layer and from the second pinned layer can contribute to switching of the free layer magnetization due to spin transfer.

27. A magnetic element comprising:

a first pinned layer;

a first spacer layer, the first spacer layer being nonmagnetic;

a first free layer, the first spacer layer residing between the first pinned layer and the first free layer;

a second free layer having a second free layer magnetization, the first free layer and the second free layer being magnetostatically coupled;

a second spacer layer being nonmagnetic;

a second pinned layer, the second spacer layer residing between the second free layer and the second pinned layer;

wherein the magnetic element is configured to allow the free layer magnetization to be switched due to spin transfer when a write current is passed through the magnetic element; and

wherein the first free layer is configured to have a first low saturation magnetization and/or the second free layer is configured to have a second low saturation magnetization.

28. The magnetic element of claim 27 further comprising:

a separation layer residing between the first free layer and the second free layer, the separation layer being configured to allow the first free layer and the second free layer to be magnetostatically coupled.

29. The magnetic element of claim 28 wherein the separation layer further includes Cu, Ag, Au, Pt, Mn, CuPt, CuMn, a Cu/Pt/Cu sandwich, a Cu/Mn/Cu sandwich, or a Cu/PtMn[1-20A]/Cu sandwich.

30. The magnetic element of claim 27 wherein the first free layer and/or the second free layer includes at least one ferromagnetic material diluted with at least one nonmagnetic material.

31. The magnetic element of claim 30 wherein the first free layer and/or the second free layer includes CoX, FeX, CoFeX, NiFeX, CoXY, FeXY, CoFeXY, NiFeXY, and/or CoNiFeXY where X or Y is Cr, Cu, Au, B, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, and/or TaCuN.

32. The magnetic element of claim 31 wherein X and Y are at least five atomic percent and less than or equal to sixty atomic percent for Cr, Cu, Au, B, Nb, Mo, Ta, Rh, Ru, Ag, TaN, CuN, and/or TaCuN and at least five atomic percent and less than or equal to eighty percent for Pt and Pd.

33. The magnetic element of claim 27 wherein the first free layer and/or the second free layer includes a multilayer including at least one ferromagnetic layer and at least one nonmagnetic layer.

34. The magnetic element of claim 33 wherein the first free layer and/or the second free layer includes a plurality of bilayers, each of the plurality of bilayers includes a Fe_xCo_{1-x} and a Cu layer, x less than one.

35. The magnetic element of claim 34 wherein x is 0.5

36. The magnetic element of claim 35 wherein the Cu or FeCo layer is greater than or equal to one Angstrom and less than or equal to eight Angstroms in thickness.

37. The magnetic element of claim 27 wherein the first free layer and/or the second free layer includes at least one ferromagnetic material ferrimagnetically doped with at least one dopdant.

38. The magnetic element of claim 37 wherein the first free layer and/or the second free layer includes CoX, FeX, CoFeX, NiFeX, and/or NiCoFeX where X includes at least one rare earth element in a range of five to sixty atomic percent.

39. The magnetic element of claim 38 wherein the at least one rare earth element is Gd or Tb from five to sixty atomic percent.

40. The magnetic element of claim 38 wherein the first free layer and/or the second free layer further includes at least one additional dopant, the at least one additional dopant including Cr, Cu, Au, Nb, Mo, Pt, Pd, Ta, Rh, or Ru.

41. The magnetic element of claim 38 wherein the second spacer layer is a barrier layer, the barrier layer being configured to allow charge carriers to tunnel between the second pinned layer and the second free layer.

42. The magnetic element of claim 38 further comprising:

a high spin polarization layer residing between the first free layer and the first spacer layer and/or between the second spacer layer and the second free layer.

43. The magnetic element of claim 27 wherein the first pinned layer and/or the second pinned layer includes a plurality of bilayers, each of the plurality of bilayers includes a Fe_xCo_{1-x} and a Cu layer, x less than one.

44. A method for providing magnetic element comprising:

providing a pinned layer;

providing a spacer layer, the spacer layer being nonmagnetic; and

providing a free layer having a free layer magnetization, the spacer layer residing between the pinned layer and the free layer, the free layer including at least one ferromagnetic material that is diluted with at least one nonmagnetic material and/or ferrimagnetically doped such that the free layer has a low saturation magnetization;

wherein if the free layer includes the at least one ferromagnetic material that is diluted with the at least one nonmagnetic material, then the free layer includes at least CoX, FeX, NiFeX, CoXY, FeXY, CoFeXY, NiFeXY, and/or CoNiFeXY where X or Y is Cr, Cu, Au, B, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, TaCuN and/or CoFeX where X is Cr, Cu, Au, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, and TaCuN;

wherein the magnetic element is configured to allow the free layer magnetization to be switched due to spin transfer when a write current is passed through the magnetic element.